the rush of new ideas excited by one after another of the wonders of civilisation, that she dies, like the Lady of Burleigh, overcome

"By the burthen of an honour unto which she was not born."

It is altogether a charming story, and is written in a style which we hope Mr. Reade will cultivate.

In justice to the author, it must be stated that the present work is intended for family reading, and to popularise a knowledge of modern Africa. He promises a more serious book, treating of many subjects in connection with the native races, of great interest to students of man; and this will be looked forward to with interest, since few men are now better qualified than Mr. Reade, both by travel and study, to tell us the real truth about the Negro. ALFRED R. WALLACE

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

Tait and Tyndall

[WE have received further communications from Professors Tyndall and Tait on the subject of the correspondence that has appeared in our columns. We feel that we are only consulting the true interests of Science in declining to print further communications on a subject which has assumed somewhat of a personal tone, and in this idea we are supported by many of the best friends of both parties, who, however, will approve of our giving the following brief extract from Dr. Tyndall's communication:—"My letter was rapidly written, and the proof of it reached me, not on the Tuesday evening, as I expected, but on the Wednesday morning when I was in the midst of my preparations for Bradford. I had therefore little time to give it the calm thought which it ought to have received. On re-reading it I find two passages in it which I think it desirable to cancel. The first is that in which I speak of lowering myself to the level of Prof. Tait; the second that in which I reflect upon his manhood. These passages I wish to retract."—Ed. NATURE.]

On the Males and Complemental Males of certain Cirripedes, and on Rudimentary Structures.

I BEG permission to make a few remarks bearing on Prof. Wyville Thomson's interesting account of the rudimentary males of *Scalpellum regium*, in your number of August 28th. Since I described in 1851, the males and complemental males of certain cirripedes, I have been most anxious that some competent naturalist should re-examine them; more especially as a German, without apparently having taken the trouble to look at any specimens, has spoken of my description as a fantastic dream. That the males of an animal should be attached to the female, should be very much smaller than, and differ greatly in structure from her, is nothing new or strange. Nevertheless, the difference between the males and the hermaphrodites of *Scalpellum vulgare* is so great, that when I first roughly dissected the former, even the suspicion that they belonged to the class of cirripedes did not cross my mind. These males are half as large as the head of a small pin; whereas the hermaphrodites are from an inch to an inch and a quarter in length. They consist of little more than a mere sack, containing the male reproductive organs, with rudiments of only four of the valves; there is no mouth or alimentary canal, but there exists a rudimentary thorax with rudimentary cirri, and these apparently serve to protect the orifice of the sack from the intrusion of enemies. The males of Alcippe and Cryptophialus are even more rudimentary; of the seventeen segments which ought to be fully developed, together with their appendages, only three remain, and these are imperfectly developed; the other fourteen segments are represented by a mere slight projection bearing the probosci-formed penis. This latter organ, on the other hand, is so enormously developed in Cryptophialus, that when fully extended it must have been between eight and nine times the length of the animal! There is another curious point about these little males, viz., the great difference between those belonging to the several species of the same genus Scalpellum: some are manifestly pedunculated cirripedes, differing by characters which in an independent creature would be considered as of only generic value; whereas others do not offer a single character by which they can be recognised as cirripedes, with the exception of the cast-off prehensile, larval antennæ, preserved by being buried in the natural cement at the point of attachment. But the fact which has interested me most is the existence of what I have called Complemental Males, from their being attached not to females, but to hermaphrodites; the latter having male organs perfect, although not so largely developed as in ordinary cirripedes. We must turn to the vegetable kingdom for anything analogous to this; for, as is well known, certain plants present hermaphrodite and male individuals, the latter aiding in the cross-fertilisation of the former. The males and complemental males in some of the species of three out of the four very distinct genera in which I have described their occurrence, are, as already stated, extremely minute, and, as they cannot feed, are short-lived. They are developed like other cirripedes, from larvæ, furnished with well-developed natatory legs, eyes of great size and complex prehensile antennæ; by these organs they are enabled to find, cling to, and ultimately to become cemented to the hermaphrodite or female. The male larvæ, after casting their skins and being as fully developed as they ever will be, perform their masculine function, and then perish. At the next breeding season they are succeeded by a fresh crop of these annual males. In *Scalpellum vulgare* I have found as many as ten males attached to the orifice of the sack of a single hermaphrodite; and in Alcippe, fourteen males attached to a single female.

He who admits the principle of evolution will naturally inquire why and how these minute rudimentary males, and especially the complemental males, have been developed. It is of course impossible to give any definite answer, but a few remarks may be hazarded on this subject. In my "Variation under Domestication," I have given reasons for the belief that it is an extremely general, though apparently not quite universal law, that organisms occasionally intercross, and that great benefit is derived therefrom. I have been laboriously experimenting on this subject for the last six or seven years, and I may add, that with plants there cannot be the least doubt that great vigour is thus gained; and the results indicate that the good depends on the crossed individuals having been exposed to slightly different conditions of life. Now as cirripedes are always attached to some object, and as they are commonly hermaphrodites, their intercrossing appears, at first sight, impossible, except by the chance carriage of the spermatic fluid by the currents of the sea, like pollen by the wind; but it is not probable that this can often happen, as the act of impregnation takes place within the well-enclosed sack. As, however, these animals possess a probosci-formed penis capable of great elongation, two closely attached hermaphrodites could reciprocally fertilise each other This, as I have elsewhere proved, does sometimes, perhaps often, actually occur. Hence perhaps it arises, that most cirripedes are attached in clusters. The curious Anelasma, which lives buried in the skin of sharks in the northern seas, is said always to live in pairs. Whilst reflecting how far cirripedes

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usually adhered to their support in clusters, the case of the genus Acasta occurred to me, in which all the species are embedded in sponges, generally at some little distance from each other; I then turned to my description of the animal, and found it stated, that in several of the species the probosci-formed penis is "remarkably long;" and this I think can hardly be an accidental coincidence. With respect to the habits of the genera which are provided with true males or complemental males:—all the species of Scalpellum, excepting one, are specially modified for attachment to the delicate branches of corallines: the one species of Ibla, about which I know anything, lives attached, generally two or three together, to the peduncle of another cirripede, viz. a Pollicipes: Alcippe and Cryptophialus are embedded in small cavities which they excavate in shells. No doubt in all these cases two or more full-grown individuals might become attached close together to the same support; and this sometimes occurs with *Scalpellum vulgare*, but the individuals in such groups are apt to be distorted and to have their peduncles twisted. There would be much difficulty in two or more individuals of Alcippe and Cryptophialus living embedded in the same cavity. Moreover, it might well happen that sufficient food would not be brought by the currents of the sea to several individuals of these species living close together. Nevertheless in all these cases it would be a manifest advantage to the species, if two individuals could live and flourish close together, so as occasionally to intercross. Now if certain individuals were reduced in size and transmitted this character, they could readily be attached to the other and larger individuals; and as the process of reduction was continued, the smaller individuals would be enabled to adhere closer and closer to the orifice of the sack, or, as actually occurs with some species of Scalpellum and with Ibla, within the sack of the larger individual; and thus the act of fertilisation would be safely effected. It is generally admitted that a division of physiological labour is an advantage to all organisms; accordingly, a separation of the sexes would be so to cirripedes, that is if this could be effected with full security for the propagation of the species. How in any case a tendency to a separation of the sexes first arises, we do not know; but we can plainly see that if it occurred in the present case, the smaller individuals would almost necessarily become males, as there would be much less expenditure of organic matter in the production of the spermatic fluid than of ova. Indeed with *Scalpellum vulgare* the whole body of the male is smaller than a single one of the many ova produced by the hermaphrodite. The other and larger individuals would on the same principle either remain hermaphrodites, but with their masculine organs more or less reduced, or would be converted into females. At any rate, whether these views are correct or not, we see at the present time within the genus Scalpellum a graduated series: first on the masculine side, from an animal which is obviously a pedunculated cirripede with well-proportioned valves, to a mere sack enclosing the male organs, either with the merest rudiments of valves, or entirely destitute of them; and secondly on the feminine side, we have either true females, or hermaphrodites with the male organs perfect, yet greatly reduced.

With respect to the means by which so many of the most important organs in numerous animals and plants have been greatly reduced in size and rendered rudimentary, or have been quite obliterated, we may attribute much to the inherited effects of the disuse of parts. But this would not apply to certain parts, for instance to the calcareous valves of male cirripedes which cannot be said to be actively used. Before I read Mr. Mivart's acute criticisms on this subject, I thought that the principle of the economy of growth would account for the continued reduction and final obliteration of parts; and I still think, that during the earlier periods of reduction the process would be thus greatly aided. But if we consider, for instance, the rudimentary pistils or stamens of many plants, it seems incredible that the reduction and final obliteration of a minute papilla, formed of mere cellular tissue, could be of any service to the species. The following conjectural remarks are made solely in the hope of calling the attention of naturalists to this subject. It is known from the researches of Quetelet on the height of man, that the number of individuals who exceed the average height by a given quantity is the same as the number of those who are shorter than the average by the same quantity; so that men may be grouped symmetrically about the average with reference to their height. I may add, to make this clearer, that there exists the same number of men between three and four inches above the average height, as there are below it. So it is with the circumference of their chests; and we may presume that this is the usual law of variation in all the parts of every species under ordinary conditions of life. That almost every part of the body is capable of independent variation we have good reason to believe, for it is this which gives rise to the individual differences characteristic of all species. Now it does not seem improbable that with a species under unfavourable conditions, when, during many generations, or in certain areas, it is pressed for food and exists in scanty numbers, that all or most of its parts should tend to vary in a greater number of individuals towards diminution than towards increment of size; so that the grouping would be no longer symmetrical with reference to the average size of any organ under consideration. In this case the individuals which were born with parts diminished in size and efficiency, on which the welfare of the species depended, would be eliminated; those individuals alone surviving in the long run which possessed such parts of the proper size. But the survival of none would be affected by the greater or less diminution of parts already reduced in size and functionally useless. We have assumed that under the above stated unfavourable conditions a larger number of individuals are born with any particular part or organ diminished in size, than are born with it increased to the same relative degree; and as these individuals, having their already reduced and useless parts still more diminished by variation under poor conditions, would not be eliminated, they would intercross with the many individuals having the part of nearly average size, and with the few having it of increased size. The result of such intercrossing would be, in the course of time, the steady diminution and ultimate disappearance of all such useless parts. No doubt the process would take place with excessive slowness; but this result agrees perfectly with what we see in nature; for the number of forms possessing the merest traces of various organs is immense. I repeat that I have ventured to make these hypothetical remarks solely for the sake of calling attention to this subject.

CHARLES DARWIN

Down, Beckenham, Kent, Sept. 20

Reflection of the Rainbow

DRAW a circle to represent a rain-drop, or rather a section of it, by a plane passing through its centre, the sun, and the eye. Draw a straight line through the centre to represent a solar ray of mean refrangibility. At the front and back of the drop reflection occurs, and the incidence being normal, the incident and reflected beams will coincide after the emergence of the latter from the drop. Now suppose the ray through the centre to move parallel to itself, the incidence grows more and more oblique, refraction occurs at entrance and at emergence, the ray finally becoming a tangent to the drop. Let the incident and the twice refracted and once reflected rays be produced backwards till they intersect behind the drop: the angle enclosed between them augments with the obliquity, reaches a maximum, and then diminishes. The ray corresponding in obliquity with this maximum angular value, and those in its immediate vicinity, quit the drop sensibly parallel, and these are the rays which are effectual in the rainbow. This angle being for red light 42°, and for violet light 40°, for light of mean refrangibility it is 41°.

If those parallel rays before reaching the observer's eye impinge

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